OTS: 60-11,554

JPRS: 2412

20 April 1960

THREE DAYS IN THE FIGHT WITH CLOUDS

- USSR -

By V. Belotserkovskiy

Distributed by:

OFFICE OF TECHNICAL SERVICES
U. S. DEPARTMENT OF COMMERCE
WASHINGTON 25, D. C.

~~Price: $0.75~~

U. S. JOINT PUBLICATIONS RESEARCH SERVICE
~~205~~ EAST 42nd STREET, SUITE 300
NEW YORK 17, N. Y.

JPRS: 2412
CSO: 3542-N

THREE DAYS IN THE FIGHT WITH CLOUDS

/ Following is a translation of an article written by V. Belotserkovskiy in Moskva (Moscow), No. 9, 1958, pages 160-170. /

To control the weather!

In this area of investigation, we have grown accustomed to our helplessness. Civilization endowed man with rather defensive and passive means of fighting inclement weather; yet, since ancient times, people have sought to "actively" influence it. They prayed to God that he would send them rains, made sacrificial offerings, and even invoked the aid of spisits.

Then came the age of steam, the age of electricity. People began to depend less and less on God and more on their own means. But the matter of controlling the weather made little headway.

Scientists began to study atmospheric phenomena, realized the vast energy that was inherent in them, but were unable to do anything about it. It is impossible, for example, to erect a barrier to the skies in order to block the cold air currents. This is possible only for nature itself, which at times raises huge mountain ranges in the path of the winds. Likewise, it is impossible to construct a gigantic ventilator to scatter the clouds. The problem of controlling weather appeared to be fantastic and insolvable.

But, in 1921, the Soviet scientists, Professors Obolenskiy and Vitkevich, said:"It can be done!" Weather can be controlled without the aid of huge dams or ventilators. The very nature of atmospheric processes, they said, is contradictory and fluctuating. Take clouds, for instance. There are forces that create them and others which seek to destroy them. We must learn to unite our forces with one of the opposites in order to be successful. But how is this to be accomplished?

Obolenskiy attempted to use powerful X-rays to change the electrical charges in the water droplets of coulds. It is well-known that identical electrical charges can form on raindrops. They in turn repal each other and prevent the

drops from developing into heavy rain formations. Obolenskiy wanted to increase the intramolecular forces of attraction. But nothing came of this. It is possible that he was led astray by the imperfect methods of the time. Perhaps in the future it will be necessary to recall this method one again and to apply it. This has often been the case in the history of science. But, at that time, i.e., the 30's, after Obolenskiy's failures many skeptics were fast to discard the idea of controlling weather.

After the war, many enthusiasts in this field once again renewed their research. Scientists in many lands participated in this work. At the end of the 40's, their endeavors were crowned with success.

Most of all, this success was connected with the application of such an ordinary and harmless substance as solid carbon dioxide, or, as it is otherwise called, dry ice. It appears that this very same dry ice we have grown accustomed to see peacefully fuming from freezers contains elements which are capable of bringing on a real upheaval in nature and of opening a new era in science. It offered scientists the possibility of interfering with the opposing forces of nature and of controlling them. Following the use of dry ice, other materials were found and other means of weather induction, and their number increases with each passing day.

The First Day

We left from an airfield near Moscow on 11 January. By "we" I mean the scientific leader of our group, Yuriy Seregin; Boris Krasnovskiy, the engineer; and Nina Smirnova, the laboratory technician. The flight crew was composed of Flight Commander K. Goran'kov, whose co-pilot was A. Grachev; the navigator R. Lin'kov, with L. Fedotov as the flight mechanic, and the flight technician, N. Frolov. The members of our scientific group were representatives of a collective of scientists and engineers who are developing methods of weather "control". Abroad, they would be known as "rainmakers".

In our land, there are several such groups working in various scientific institutions. Their work is coordinated by a committee headed by a member of the Academy of Sciences USSR, Ye. K. Fedorov, who was a member of an expedition to the North Pole in 1938. I flew with a group from the Central Aerological Observatory. The purpose of our flight was to experiment with a unique automatic cloud-seeder, using solid carbon dioxide.

Where were we flying? We learned this only a half-hour before take-off time. Yuriy Seregin, who had just studied the latest weather charts, selected Rostov, where there were many "good" or suitable clouds.

From the outside our plane was no different from any of the IL-class, but inside it was a veritable laboratory. Along the walls there were large tanks and cylinders which were interwoven with pipes. There were white hermetically-sealed containers, and various other instruments on the ceiling and along the windows. Several chairs with tables could be seen and on these tables there were still more instruments. There was even a microscope on one of these tables.

At the very end of the tail section of the plane stood a white-enameled, built-in cabinet. Here one could find a control panel, lamps, and still more instruments which were being examined by a young man who was on his kneew.

"Why don't you get acquainted?" Seregin asked me, looking at him. "He is Comrade Krasnovskiy, the builder of this apparatus of ours which we are flying to test. This is our machine," he said running his hand along the cabinet.

I had heard much about this instrument, the first of its kind in the world, and must admit was a bit astonished at seeing its chief designer, who gave the impression of an ordinary young worker.

The loading of dry ice began. The marble-like ice crystals sparkled. They were being packed in white hermetic containers.

Finally, all was ready and our plane soon became airborne.

When we were already in the air, our flight mechanic came out of the cockpit. I was standing in the doorway. The Commander peered at me several times over his shkulder and, unexpectedly beckoning with his finger, motioned me to the flight mechanic's seat.

"Are you one of our new workers? Are you going to fly with us?" he asked. "No", I replied, "I am from the magazine". The Commander smiled, but I could feel that my reply somewhat disappointed him.

Konstantin Dmitriyevich Goran'kov proved to be a very

amiable person. The plane was being guided by its automatic pilot and the both of us began to talk. Most of our conversation, of course, dealt with aviation. Gorankov was an old air wolf. At the age of sixteen, he was already sitting behind the control panel of a plane and by now had almost 3 million air kilometers to his credit. He spent the war flying long-distance bombers and had worked as a test pilot.

His hands caught my attention. The skin was a strange, waxy color. I at once understood that it was not natural.

Goran'kov would not tell me much of how this had happened. I learned, however, that during the bombing of the city of Nikolayev, German artillery fire had hit the left engine of his plane. He was compelled to make the return trip on one engine alone. It was impossible to put out the resulting fire and soon the floor of the cabin was in flames. It was comparatively close to the front lines and Goran'kov was able to land in a neutral zone. He had covered his face with his hands and only because of this had it not been disfigured.

Later, Goran'kov's plane was hit six more times during the war, but somehow he always managed to get back to the vicinity of our lines.

As he talked, Konstantin Dmitriyevich continued to watch the instrument panel as well as his co-pilot and from time to time read reports of the condition of our air route, which were handed to him by the radio operator. After he had read them, he would express his favorite "so-o" and would carefully pin the reports on a special wire as bills are pinned down in stores. At times, the co-pilot would motion to him and Gorankov would put on his earphones and, applying his throat-microphone, would speak to the stations on the ground.

"We must fight not only the clouds, but also the dispatchers on the ground," he said after one of these conversations. "In our work we are often obliged to change our air route, our altitude, or our position. But they, on the ground below, do not approve of this," he added.

"But, I believe, you have special permission for this from higher authorities in the Air Ministry?" I said.

"Yes. But they have issued a refusal signed by no lesser an authority. Thus, we must fight. This past summer, for example, there was a case like this. We took off to seed

cumulus clouds. They are very dangerous to all aircraft. If a plane should pass along the lower edges of a cumulus cloud, it could become absorbed by it, from which there is little escape. But we seed the clouds from above. As we flew out to seed a cluster of cumulus clouds, we suddenly received an order which prohibited us from approaching 'any formidable cumulus clouds'. I then asked the dispatcher below: 'And what do you mean by a formidable cumulus cloud?' Since the dit-patchers remain on the ground they have no sense of humor. He replied by saying angrily: 'This is an order! Keep away from all cumulus clouds!' So we were obliged to turn back. Can you imagine what a waste of time and expense this was?"

At that moment, Seregin entered the control cabin and I was politely asked to make way. We had been flying over the clouds for a long time now and were nearing the seeding-area. I entered the main compartment of the plane and sat down by a window which was enclosed not by an ordinary flat-surfaced glass, but by a convex or bulging-type, which permitted one to lean out and observe what was occurring underneath the plane.

The clouds were all around us, reminding one of the thick waves of an unusually white sea. In fact, this was a sea, only its moisture was in the form of droplets.

Boris Krasnovskiy opened his "cabinet" and placed some dry ice in it. We were getting ready for the first test. The depth of the clouds below reached 600 meters. Our plane began to descend and soon plunged into the clouds. Before the "operation" could be carried-out, an analysis of the situation had to be made. The moisture-content of the cloud had to be measured, as well as the size of the water-droplets, plus a temperature reading. This was done by Seregin together with Nina Smirnova, who carefully scrutinized the instruments which were attached near a window of the plane. Both were very busy but they conducted their activities efficiently and with dexterity.

When all the readings and measurements had been completed, the plane once again left the clouds but continued to fly close above them, and at times was able to penetrate the higher cloud "waves." At this time, the plane would violently sway and would literally pierce not merely a cloud but a real wave.

"Well," I asked Seregin, "how are present conditions?"

"Bad!" he replied. "Plus 3 degrees on the upper edge!"

The fact is that the use of dry ice is designed for supercooled temperatures. It was indeed very cold on the ground. But here, at an altitude of over 2,000 meters, a "thaw" had set in. We had been caught in a current of warm air.

"We shall continue with the experiment nevertheless," Seregin said angrily. "Of course, I cannot vouch for the result. In my opinion, something will come of it. The temperature is lower within the cloud. While on the lower edge it is minus three. Let us try. Connect it, Boris!" he ordered Krasnovskiy.

Krasnovskiy turned a knob on the control panel, pressed a button, and his "cabinet" began to run.

Special blades revolving at a speed of 3,000 revolutions per minute, started to cut into a block of ice, dividing it evenly into equal pieces measuring one centimeter. They were then separated into cubes and automatically deposited in a bin under the floor. The cutting of the ice into cubes as well as their output was carefully regulated. Due to unfavorable outside conditions, the yield was at its maximum: 3,000 grams per minute. From time to time a strange sound came from the box. Krasnovskiy explained to me that this was a result of the pneumatic clamp pressing the ice against the cutting blade.

"But this apparatus can operate without the clamp," Krasnovskiy said enthusiastically. "It will run even if its other mechanisms fail. Of course, it will not operate up to par, but even so it will work. Vitality is our main principle in aviation."

Boris continued to explain the operation to me while, I must admit, I was more interested now in waht was happening below us, where the cubes of dry ice were dropping one after another. Could these tiny lumps, of which there would hardly be enough for a single freezer on a good summer's day, really destroy this sea of clouds?

I was curious to see for myself, as I looked through the window.

"At any moment the plane will turn back and you will see for yourself," Boris said, having seen the impatient look on my face.

At this moment, the plane banked to one side and turned. Soon it was flying level once more. That meant that we were flying back over the area we had just seeded. At that moment, I heard the fliers cry out: "Vadim Vladimirovich! Vadim!" This, of course, was Seregin and by the intonation of his voice I could note that all was in order. We had overcome the "situation."

I ran into the cockpit. Seregin and Gorankov were pointing to something ahead and below. But I could see nothing. That is to say, I could see only what I had observed before -- endless waves of clouds.

"Do you see it?" both asked me in one voice. "See, over there!" It was a dark, washed-out patch which was centered around the area we had just flown over.

Now, I could really see the patch where the clouds had darkened, as if before a sotrm. "Konstantin Dmitriyevich," Seregin said in an excited voice, "why don't you fly a little higher? Then we shall see the reflection of the sun, that is the reflection of the sun's rays against the myriads of ice crystals, as well as the snowfall."

"And we shall not see the ground, Yuriy Alekseyevich?" I timidly interrupted him, feeling that by my rude question I had insulted science.

"The ground? Oh, so that's what's bothering you!" Seregin laughed. "Surely! In about ten or fifteen minutes. The entire procedure takes from twenty to thirty minutes. As soon as we are finished, the reflection will disappear and you will see the ground."

I sighed with relief and began to search for that wonderful reflection of the sun -- the "lower sun" as they called it. And there it was, brilliantly shining in a silvery hue on the cloudy path we had just furrowed. I would have called it a lunar reflection, however, because of its silvery lustre.

In the meantime, the furrowed path which we had made in the clouds grew wider and larger in size and all the more reminded one of a thawed patch of snow as if a hot pipe with steam had passed through here. But soon the furrow ended and again we turned back where we could see how the snow in the clouds "had melted to the ground." To the left and to the right of us the clouds passed by majestically as before,

full of icy splendor, and below us there remained but pathetic foggy patches. With added interest I gazed at the ground which could be seen through the "gully" we had made in the clouds. The streets were covered with fresh snow along which dark trucks were slowly crawling and were being passed by Pobeda motor cars, resembling lady bugs. A village could be seen near the road. We could also see the reflection of the sun on the toy-like domes of a tiny church. The villagers probably had been astonished by the sudden appearance of the strange clouds.

What had really happened below us? How were these minute particles of dry ice able to perform such a huge task?

We have become accustomed to water turning into ice at freezing temperatures. At any rate, this occurs with water during the first frosty autumn night. But it so happens that water in the form of droplets does not freeze in the clouds with the coming of cold weather. It is said that it is merely recooled and can remain in this form to a temperature of minus 40 degrees C.

An analysis of the causes of this phenomenon would lead us far astray. The only important thing to be mentioned here is that the recooling process of water in cloud droplets is one of continuous change. Scientists finally decided to utilize this fluctuation to their advantages. As dry ice vaporizes, it cools the air surrounding it to a temperature of below 40 degrees Centigrade. As the droplet of water passes through the cloud, it leaves behind it a path of very cold air and the moisture along this path finally freezes. Minute beginnings of light snowflakes are then formed. The moisture in the cloud begins to freeze rapidly into ice crystals. The crystals grow and increase in weight as the drops vaporize and disappear. All of the moisture from the droplets is transformed into crystals. These in turn form into heavy snowflakes which the air is unable to support and consequently they begin to fall. A cloud seeded with dry ice ceases to exist.

Thus, by dropping dry ice into a cloud, we merely start the process by interfering with the transmutating equilibrium of the opposing forces in nature. The process takes its own course after this without our interference. In this case, we only assist the intramolecular forces of attraction which are seeking to change water into a solid.

Only 100 grams of dry ice are required to seed one cubic kilometer of a cloud and turn it into snow.

But all is not as simple as it may seem to appear. The difficulty, first of all, lies in the amount of application. The adage that "you cannot ruin porridge with butter" is not suitable here. If more dry ice is seeded into a cloud than is required, the results will be nil. A so-called "overseeding" will occur. This means that too many drops will freeze simultaneously and the snowflakes will hardly increase in size.

Under normal cloudseeding, moisture adheres to the frozen crystals at the expense of the vaporization of the adjoining aqueous droplets. If these should freeze, then the moisture will be unable to escape and, as a result, the crystals will not grow in size and there will be no snowfall. The cloud will merely alter its appearance. Its composition will not be one of droplets, but it will be made up of light snowflakes. We will get neither snow nor rain. It will continue to remain as a cloud. In the final analysis, too little and too much is bad. A certain optimum dosage is necessary. It is difficult to determine its relative quantity or intensity. The difficulty of the matter is still aggravated when the dosage depends entirely on the condition of the cloud, its temperature, its moisture content, and the speed of the air currents.

The solution of these problems is conducted through frequent experimentations and theory. But theory, alas, still lags far behind from actual practice. Mankind, having penetrated the secrets of the atom, is still unable to probe successfully the secrets of the clouds. Not a single living scientist, for example, will speculate on fully resolving the causes and mechanism of natural rain, hail, storms, etc. But life and technical knowledge, having outdistanced science, are now demanding an answer to the mechanism of artificial rain and snow. Difficult are the times, indeed, for science!

The Second Day

When we awoke in the morning at the Rostov airport hotel, we looked into the window and were overjoyed by what we saw. Everything beyond was covered by a layer of dense, gray fog. One could not hear any engines warming-up. A somnolent stillness seemed to blanket the airfield.

Rostov was "closed" to all traffic. Some of the grounded passengers, who were neighbors of ours in the room, were cursing both themselves and the weather and were admonishingtthemselves for not having taken the train instead. We, on the other hand, were delighted. Nature had challenged us. Now we will show her!

"Cheer-up!" we told our neighbors. "Let us have breakfast and then you can take off!"

They gazed at us with astonishment and even with some anger at our strange and inappropriate joke.

We ate in a hurry, after which we ran to our plane. It was difficult for us to find it, since it was hidden in the dense fog. It was standing there -- silent and dreary.

"What is the matter? Why are the motors not being warmed up?" we shouted at the mechanics. They looked gloomier than the plane itself. The technicians who were servicing the plane had found a damaged part in the engine. We immediately hurried to the administrator of the airfield and requested him to help us in speeding up the replacement of the damaged part. "We shall open up the airport for you," we shouted. Without any further ado he mobilized an entire brigade of workers to help us.

Our anxieties having been allayed somewhat, we returned to the hotel and began to play chess. The delay was naturally disappointing, but "all's well that ends well."

How quickly the surroundings of the airport were changing! It was only nine o'clock in the morning, but already the halls of the terminal building were crowded with waiting passengers.

"That is nothing," we thought to ourselves; "soon everything will be in order."

We had played one game, and had begun another, and still we were not called.

Finally, the navigator, Robert Lin'kov, appeared. Always happy, he now wore a strange look.

"Bad news!" he said. "The engine will not be repaired today."

The airport was already beginning to remind one of a railroad station. There were people sitting on the floor, on their personal belongings, in the lobby, and in the hallways. And this was happening not only in Rostov. Aircraft that was destined to land at Rostov or pass over it were grounded. This cost the State hundreds of thousands of rubles.

Out of embarrassment, we turned our gaze from our neighbors. We recalled how scientists in Moscow had proudly related one practical result of their labor: they quoted the existing laws governing the opening of airfields in wintertime.

Once again, we renewed our discussion with the head of the Rostov airport.

"Do you have instructions?"

"I do."

"Then, why don't you lift the fog from the airfield yourself?"

"We have attempted to do so twice, already."

"And what were the results?"

"We had some success."

"Then, why are you not doing it now?"

"Why?" the chief sarcastically smiled. "Your special apparatus is on board ship, while ours is still in its primitive stage -- we use an axe. We must manually chop the ice in the plane itself. On one occasion we even chopped through the floor. The ice must be broken up before it is scattered over the clouds, otherwise it will vaporize. We also have a problem in obtaining the dry ice. Rostov does not have a factory which could produce it. When we get a machine like hours, a machine that will also automatically cut the ice into small cubes, then you can come up with such a question. That is how it is. The instructions look simple on paper only!"

There was nothing that we could say to this.

"He is right about the mechanization," Seregin said.

"It is difficult to work with an axe. But I'll tell you one thing. If from his pay only a small part of the cost of this delay were deducted, he would be fast to find a solution. All they fear are accidents. They follow the rules stringently as far as accidents are concerned. But while the planes are grounded, how can there be an accident?"

"Please tell me, Yuriy Alekseyevich, when was the construction of your apparatus started?"

"In 1955."

"Is it not taking a long time?"

"Yes. It is not fast. But that is no fault of ours. We do not have our own construction bureau. Our orders for equipment are placed with plants who fulfill them over and beyond their plans. It stands to reason then that they do not work on them in a hurry. Then changes in plans have to be made and various tests. This is the second year that we have been conducting tests!"

"When do you expect your apparatus to be installed at airfields?"

"I cannot say... It will not be soon," added Seregin sighing. We'd better go to town!"

There was nothing else to be done at the airport.

On the way to Rostov, I got into a conversation with Krasnovskiy. I asked him to give me more details on how he came to build his machine.

He tried to evade the question.

"Now, look here," he replied; "you journalists like to talk... 'your machine,' 'the apparatus of so-and-so, etc.'"

"Tell me how it happened," I sought to calm Krasnovskiy.

"How? As always is the case: many cooperate..." Krasnovskiy began to hesitate. "Some work more, some less."

One could still note a look of suspicion in his eyes, but I waited patiently. I guessed that he himself wanted

his work. I was not wrong. Krasnovskiy gradually relaxed and soon forgot his misgivings.

"You understand, don't you?" he would ask me from time to time. He would continue, not permitting me to reply: "Nothing was ever accomplished in this field. We rummaged through all the libraries -- but to no avail. We knew neither the principle of the machine's operation, nor the mechanical characteristics of dry ice. We tried chopping it and planing it -- still nothing happened! All we could get was dry ice in powdered form and not as cubes. Powdered ice is worthless because it will evaporate before it has a change to pass through a cloud. Then we tried pressing it and even cutting the dry ice by means of an electrically-heated conductor."

One could feel that Krasnovskiy not only liked his work, but considered his specialization to be in the forefront of all others. Despite the fact that he stubbornly and sincerely refrained from using personal pronouns such as "I," "mine," etc, I was still able to understand that out of three similar projects, his was the one that was selected. It was based on the principle of cutting ice by a cogged cutter at a speed of 3,000 revolutions per minute. It has been found that only at this speed is the pulverization of brittle dry ice avoided.

The work on it progressed satisfactorily, except that in the beginning the machine itself, together with all its accessories, occupied almost one half of the fuselage of an IL-12. Naturally, this was inadequate. Much ingenuity and labor were required before it was possible to transform this apparatus into the miniature and faultless cabinet that it was and which was now breathing and champing in our plane. The following is a far from complete list of those who, together with Krasnivskiy, participated in the creation of this much-needed apparatus for our air force. Among them were the designers Averyushkin, Nekhroroshikh, Salfetkin; the technician Eremina; the electricians Kvyatkovskiy, Marshev, Goryachev, and Strel'tsov; the technologists Tormashev and Dmitriyev; and the locksmith, Borisenko.

"Is this work your first?" I asked Krasnovskiy.

"No, it is not the first," he replied smiling. "But it definitely has played a major role in my life."

It turned out that during the initial tests of .

Krasnovskiy's apparatus, he had become acquainted with a research student at the aerological observatory, a Lyudmila Krutskaya, who was working on the theoretical principles of weather control. They were married recently.

All in all, as I came to understand, this past year, Krasnovskiy's twenty-ninth, was an important one for him. During the summer, he had graduated from the Moscow Institute of Aviation, which he had attended as a night student, and he was also able to obtain, together with his wife, a room in a new home.

The Third Day

Alas, fate cannot be kind twice. The sun was shining outside our window, the motors were roaring, and it appeared that we were not destined to distinguish ourselves in Rostov. Truly how pleasant it would have been to perform a good deed. All were sorry that the possibility had slipped by. No matter what is said, there still exists a sharp distinction between an experiment, even the most interesting kind, and its practical realization. This we well understood that day in Rostov.

From Rostov, we flew on to Mineral'nyye Vody. A testing of the Central Aerological Observatory was situated here. Ground devices for the dispersal of fog from airfields were being tested. This work was conducted by a member of the C.A.O., the engineer Orest Rabinchuk.

Soon after we had left Rostov, the ground became covered with heavy clouds. They continued to grow denser and larger. The fliers confirmed the existing opinion that there cannot be two days when the clouds would be identical. If yesterday the clouds reminded us of a sea under a fresh wind, then today we were flying over a stormy, choppy one. White waves were rolling below us.

An especially beautiful scene unfolded when we approached the foothills of the Caucasus. Even the experienced veteran fliers were amazed. The mountains below were not visible but the clouds kept rising in one huge wave. Literally speaking, this could have been a breaker or an oceanic earthquake. The wave's crest kept winding and rising in a spire, and appeared to be in one position, refusing to subside. It proved to be a stationary one.

In the meantime, we received a report from the ground

that while we had been admiring the clouds, they in turn had settled over the airport in Mineral'nyye Vody and, consequently, the field was closed because of the low ceiling. This only proved the point that the cloud wave was capable of subsiding.

We had planned to work in the area of Mineral'nyye Vody. Now, it was decided that we would operate over the airfield itself so that we could set it open and make a landing. This was really a job. It was made more difficult by strong winds which are treacherous here at the approaches to the Caucasus. The wind was so strong that an opened plane window would have been blown out past the airport. All our hopes were now concentrated on the navigator Robert Lin'kov. It was his responsibility to determine where to "bomb" the clouds.

At this moment, an interesting conversation took place on the radio between our commander and the dispatcher. The former requested permission to work above the airdrome.

A pilot of a grounded plane interfered in this discussion. "What will he be doing?" he asked.

"He will try to open our airfield," the dispatcher replied.

"He is a good fellow," answered the pilot.

"We finally got a compliment," smiled Konstantin Dmitriyevich. "We have to justify it."

Lin'kov completed his calculations and our plane took off against the wind, leaving a winding trail behind it. The apparatus breathed and champed in a now familiar fashion as it began to seed the clouds with its little "bombs". The clouds behind us began to darken and again we saw the bright reflection of the sun. As we completed our "bombing" run, we increased our altitude a bit and earnestly began to look at the dark crevices we had made in the clouds. At this time, a report came in from the ground that it was snowing heavily and the visibility had worsened.

"Quietly, peacefully! Everything is progressing intelligently," Seregin tried to calm us as he used his favorite expressions.

But it seemed to me that he was really trying to

compose himself.

We had made two round trips over the seeded area with the prescribed 30 minutes expiring, but still we could not see the ground.

"It has stopped snowing!" came the report from the ground. Apparently, they, too, had begun to worry.

"Why should we care?" someone said, probably having lost all hope of seeing the ground. The commander observed that the wind from the mountains was beginning to cover the crevices we had made with fresh clouds. "Will we actually have to return to Rostov in disgrace?" we wondered.

"Poor Orest!" Krasnovskiy said. "He is probably running around the airport, waiting for us." At that instant, Seregin shouted from the cockpit:"Land!" I was firmly convinced that only Columbus could have shouted like that before him.

Everyone rushed to the windows. Yes, there was the land. True, it was still a bit hazy, but one could see the houses, fields, and roads.

They radioed from the ground that the sun was out over the city and visibility was at 500 meters.

All was in order. The airfield was just outside the city. Soon the sun would appear there too.

Konstantin Dmitriyevich contacted the dispatcher for permission to land. "Permission granted!" came the reply. "The altimeter reading here is 762 millimeters." (This information is essential for all fliers for a precise determination of their altitude).

We circled the field once, then twice.

"Is your landing gear down?" the dispatcher asked authoritatively.

"Certainly," replied Goran'kov.

The instrument panel began to ring. This automatically informed the pilots of whether or not the plane was making a satisfactory landing approach. We could see below

below us a clearly-outlined runway, which was marked off with lights. There was a slight jolt as we made our landing.

Later a banquet was held where our expedition met the local winter vacationists who were staying in Mineral'nyye Vody. This turned out to be a very bad season for them -- it was a terribly cold, raw, and windy winter. The sun came out over Mineral'nyye Vody only with the arrival of our plane. One can say, it was artificially produced.

The local fliers as well as the workers from the airport also attended the banquet. They all knew and admired the associates from the Central Aerological Observatory who were conducting weather induction and the conversation here naturally centered around their work.

At times cumulus clouds attain a height of 10-12 kilometers. In order to "work the cloud over," so to say, the plane must achieve an altitude above the cloud's summit, which aerologists like to call the "anvil" point. The work is carried on with the crew working in oxygen masks. Before a cloud can be seeded they must determine whether there is any precipitation. This is also a very crucial moment.

"Once," Seregin said, "as we were flying under a cumulus cloud, darkness suddenly and swiftly began to set in. The pilots called me and said that it was only with difficulty that they were able to control the plane. The aircraft literally was being absorbed by the cloud. They were hardly able to decide what to do, when a bolt of lightning pierced the darkness, miraculously by-passing the plane. A heavy storm began. The fliers, forgetting everything else, suddenly banked the plane and with full speed started to climb over the cloud."

Thunderstorms and hailstorms are born in large and developed cumulus clouds. As I came to understand from the gist of the related stories, this is one of the reasons why any struggle with cumulus clouds bears such important significance. In contrast with other clouds the cumulus type are distinguished by their aggressive, turbulent and, I would say, predaceous nature. To look at, they are very picturesque and have often inspired poets. But within them are hidden huge destructive forces. It is a laughing matter for them when they are able to swallow an unsuspecting plane, thereby destroying it by breaking it

into tiny bits. The energy of an "average" cumulus cloud is approximately equal to an atom bomb. During a seemingly calm and sunny day, cumulus clouds are actually furiously seething with tornadoes and windstorms. Storms are caused when electrical charges forming on water droplets achieve a critical point.

The hail found in cumulus clouds is a deadlier and more appalling "weapon" than lightning. Though people do possess defensive means against lightning, on the other hand, man has found himself to be helpless in his battle with hail formations.

Hail causes especially huge losses to the agricultural economies of southern countries. Hailstorms occur more frequently in southern climates than they do in our zone and cause severe damages to the delicate plants in those areas. During certain years, hail completely destroys grape harvests. Hail is as much of an enemy to winegrowers as draught is to farmers.

Cumulus clouds are "hostile" to man in all forms and phases. Even when they bring on a downpour of rain, they cause more harm than good. They have been "brutalizing" man so long and so precisely that he has grown accustomed to his fate, annually paying a heavy price without complaint. This is one of the reasons why plans for putting an end to hailstorms and other squalls in the not too distant future or, at any rate, of significantly curtailing them, appear to be so farfetched.

An expedition from the Academy of Sciences USSR, headed by Professor Sulakvelidze, is now conducting tests on hail modification in the Valley of Alazyansk. Its method consists of plans to break up formations of cumulonumbus clouds before they have a chance to grow into heavy layers of hail. In order to observe the formation of cumulus clouds in time, the utilization of radar and aerial reconnaissance is being considered at the approaches of the fertile valleys of the south.

In France, for example, where winegrowing plays such an important role in the agricultural economy of the country, cumulus clouds are bombarded from the ground by rockets which are loaded with suitable substances.

Today, however, the basic problem which confronts

science in the early stages of weather control is the dispersal of the warm clouds of summer.

As we approached Moscow, while we were saying farewell to each other, I managed to ask Sasha Grachev, our co-pilot, what he as a flier thought of the work of weather induction, which was being conducted by scientists.

"Undoubtedly, it is of primary importance," replied Sasha, "but it is progressing rather sluggishly."

His words became imbedded in my mind -- especially the word "sluggish." In my estimation, it clearly depicted the situation. Back in 1921, Vitkevich and Obolenskiy had laid the groundwork for weather induction. How much could really have been accomplished in the period of time since!

The attitude of the Agricultural Ministry toward science's attempts and achievements in influencing weather gives cause for special concern. The collective system opens up exceptional opportunities for the development of artificial means in the augmentation of precipitation.

It should be pointed out that specialists in this area of investigation are not being trained. The profession of "weather induction" demands knowledge in chemistry, physics, mathematics, and meteorology. Those who are now entering the "ranks of the fighters of the clouds" must add new information to their knowledge, as well as brush up on new findings. As a result of this, time is lost and the matter consequently suffers.

When we spoke of the practical application of the means of influencing weather we mentioned only their use for the opening of closed airfields and the dispersal of thunder and hail storms. But this is a far cry from what still can be accomplished. The prospects of the future are bright. It is difficult to overestimate their value.

With the installation of apparatus on collective farms for seeding clouds with active substances, or by their dissemination with the aid of balloons or rockets, we shall be able to obtain artificial snow or rain. As a result, we shall be able to increase the water content in reservoirs for our hydroelectric stations. By the process of "overseeding" the clouds, or by using special agents in

conducting the operation, mankind on the other hand will be successful in preventing the accumulation of superfluous and unnecessary rain or snow.

The freeing of wide land expanses from cloud formations will result in the warming of layers of overground air in the artificially-opened areas. Consequently, the pressures and directions of air currents will change in these regions. On the other hand, an "overseeding" of the clouds, of which we have already spoken, can prevent a natural cloud dispersal. This, in turn, will change the thermal balance and direction of atmospheric air currents.

By conducting work in this field, we shall be successful in changing the weather on a large scale. In the opinion of many noted world scientists, all of this is only a matter of the near future, of the next two decades!

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This publication was prepared under contract to the
UNITED STATES JOINT PUBLICATIONS RESEARCH SERVICE,
a federal government organization established
to service the translation and research needs
of the various government departments.